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Machine Learning Methods Applied to Biometrics

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Abstract

Biometrics is a challenging field which uses physiological and behavioral characteristics of persons in order to establish their identities. Biometrics research requires the fusion of several other fields, fields that are in a continuous development. Among these fields we find image processing, pattern recognition and machine learning. There are many research oportunities in this field, some of the most recent ones being cross-sensor comparisons, liveness detection (in iris recognition), behavioral biometrics and mobile biometrics. My PhD thesis will contribute by applying Machine Learning methods at least for some of the enumerated research oportunities.

Keywords Biometrics, Pattern Recognition, Image Processing, Machine Learning

I. Introduction

Biometrics is a field with continuously increasing areas of application, such as financial services, mobile device access or border control. Shortly, biometrics is represented by automated methods of identifying persons, based on their physiological and behavioral traits. Some of the physiological traits are iris, face, fingerprint, and vein. Examples of behavioral traits are signature, gait and keystroke dinamics. In the past years there have been made many advancements in this field, especially when it comes to biometrics in controlled environment, where factors such as lighting are held under control. Lately, the researchers attention started to switch to unrestricted environments, where there is no human agent present to supervise the proper usage of biometric systems.

II. Related Work

In my opinion, the most impressive research results have been reported in the past two years. For instance, in 2014 Yaniv Taigman et. al. published a paper [3] on face recognition in which they presented a method of verifying identities with an accuracy up to 97.35%, really close to the human performance, which is 97.5%. As far as I know, these are the best results published in biometrics scientific literature on face recognition, up to the moment. Other important results have been presented by Marios Savvides, from Carnegie Mellon University's CyLab Biometrics Center. Savvides and his colleagues have developed an iris recognition system [2] that is able to establish the identity of individuals from approximately 12 meters. The biometric system is designed especially for police cars, helping to establish the identity of the car drivers that are pulled over, by acquiring images of their eyes from the side-view mirrors.

Getting closer to the area of my recent work, in [1] the authors proposed an iris segmentation algorithm for CASIA-Iris V4 Lamp database, algorithm that acquires a 95.63% accuracy in detecting the pupillary boundary and a 90.52 overall segmentation accuracy (i.e. determining both the pupillary and limbus boundaries).

III. Thesis Idea

The need to correctly establish the identity of individuals is constatly increasing nowadays, mainly due to technological progress. This is why biometrics is a still

flourishing domain, enjoying the attention of many researchers. The following directions are some of the ones that captured my attention as well:

- Developing new image segmentation procedures;
- Signal processing;
- Machine Learning algorithms;
- Solving problems that characterize the biometric systems which have an increasing number of users. When the number of users is increased, the chance of occurring false accept or false reject cases is high.
- Also, one of the interests in biometrics research is evaluating and analyzing the weaknesses of biometric systems. In other words, it is important to correctly identify any forgery attempts.

My work is primarily focused on applying Machine Learning methods in biometrics. For instance, one of my previous work consisted in applying a modified unsupervised neural network, ART 1 (Adaptive Resonance Theory of type 1), in iris recognition. The neural network is modified in order to classify input patterns (iris codes) given in a random order. This new characteristic of the network allows an easy identification of any person who attempts to pass a biometric verification by using a fake identity. False Acceptance Rate and False Rejection Rate, two performance indicators in biometrics, have obtained null values in all of the tests performed with the modified version of ART.

IV. Conclusions and Future Work

My research was focused so far on iris recognition, wehther it was about testing concepts such as biometric menagerie, testing several neural networks, such as PNN (Probabilistic Neural Network) or ART 1, or performing cross-sensor comparison. During the remaining time of my PhD studies I intend to extend my research to other biometric traits as well, but, for the moment, I work on developing a segmentation algorithm for iris images, algorithm that will allow me to approach other current research topics in iris recognition, such as liveness detection.

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